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Original Article

# The effects of exercise using an ergometer with swaying saddle on chronic lower back pain

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**Abstract.** [Purpose] This study aims to investigate the effects of exercise using an ergometer with swaying saddle on chronic lower back pain. [Subjects and Methods] Thirty-three normal adults (university students) with chronic lower back pain were randomly recruited. The flexibility and strength of muscles were measured before and after an 8-week intervention. Belly-bike, an ergometer with a swaying saddle, was used. The duration of intervention was 30 minutes a day, 3 times a week. To measure the level of pain, visual analogue scale (VAS) and Korean Oswestry Disability Index were used. In addition, flexibility tests such as straight leg raising and forward reaching test in the long sitting posture were used to confirm back muscle shortness. Activations of the erector spinae muscle, gluteus medius muscle, rectus femoris muscle, and vastus lateralis muscle were also measured by electromyography before and after the intervention. Electromyography of muscles around the pelvis was performed and functional tests were conducted. [Results] The flexibility and strength of the muscles significantly increased post-intervention. Functional test scores for the forward reaching test and straight leg raising test significantly improved in the Belly-bike group. [Conclusion] The results show that exercise using the Belly-bike could be effective in reducing lower back pain.

**Key words:** Lower back pain, Belly-dance, Ergometer

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## INTRODUCTION

Lower back pain is the most common disease in the modern society. It is diagnosed as chronic pain when the pain lasts for more than 12 weeks[1)].

There is a consistent relationship between chronic lower back pain and other complications. People with lower back pain have a higher psychologically stress level than those without[2, 3)].

Many studies have reported that lower back pain is secondary to problems of related to muscles[4)]. According to Janda's lower crossed syndrome (LCS), the crossed couple of force causes pelvic problems between the trunk and lower limbs. In addition, abnormalities of muscles such as pelvic flexors, knee extensor, and abdominal extensor could occur in the posterior tilt of pelvis[5)]. The muscle involved iliopsoas muscle, rectus femoris muscle, hamstrings muscle, erector spinae muscle, rectus abdominis muscle, transversus abdominis muscle, obliques muscle, gluteus medius muscle, vastus lateralis muscle and vastus medialis muscle.

Weak muscle endurance of the abdominal extensor is strongly related to chronic lower back pain. In particular, multifidus, the core muscle, has an attachment point on the segmental unit of the lumbar vertebrae, which prevents pain by providing stability of the segments[6, 7)]. Furthermore, Nadler reported that the gluteus muscle becomes weak in patients with lower back pain or impaired lower limb; this weakness can cause inactivation of the pelvic flexors, rectus femoris, and hamstring

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**Table 1.** General characteristics in groups

| | Belly-bike group |
|---|---|
| Gender (M/F) | 11/12 |
| Age (years) | 77.9 ± 6.3 |
| Height (cm) | 156.5 ± 3.4 |
| Weight (kg) | 55.0 ± 7.1 |

Mean ± SD

**Fig. 1.** Belly-bike
(1) Side view (2) Back view (3) Back view
(1) Overall appearance, (2) Left side swaying, (3) Right side swaying

muscles, resulting in dynamic problems. As a result, weakness of gluteus muscles could necessitate treatment of lower back pain[8–10].

A functional decrease such as weakness of muscles and ligaments around the spine occurs due to the lack of exercise, which is the main risk factor for lower back pain. Muscle weakness causes functional disorder or pain, leading to disruption in activities of daily living and occupational activities. Furthermore, it can cause abnormal posture, resulting in anxiety symptoms and recurring pain[7, 11].

However, the risk of impairments can be reduced by core exercise and stretching exercise involving the hamstring and flexor muscles around the hip. Similarly, the purpose of exercises for lower back pain is to increase muscle strength, muscle endurance, and flexibility[12, 13].

In general, many interventions have been used such as fitness training, yoga, and belly dancing to increase back muscle strength. Belly dancing has been reported to improve the muscles around the spine and pelvis and help in the correction of abnormal posture, especially among other interventions[14, 15]. Although many studies have reported that belly dancing has positive effects on functions of the back muscles, there are many controversial opinions. Furthermore, many therapists believe that belly dancing is not affordable when compared with other exercises, because of the associated high cost and time[15, 16]. For this reason, Belly-bike—an ergometer equipped with a swaying saddle and offers the belly dance function—was developed in Korea so that many people could easily perform belly dance and ergometer at the same time. Belly-bike is believed to provide the effects of belly dance and health ergometer and should be affordable for most people who have lower back pain.

Thus, the purpose of this study was to investigate the effect of Belly-bike for muscle strengthening and eliminating lower back pain.

## SUBJECTS AND METHODS

Thirty-three university students with chronic lower back pain were randomly recruited in this study. The exclusion criteria were as follows: 1) other orthopedic diseases, 2) impairments in vision or visual deficit, and 3) psychological or cognition problems. The inclusion criteria were as follows: 1) 5 score more from KODI (Korean Oswestry Disability Index), 2) back pain for more than 3 months at the time of pre test. All subjects understood the purpose of this study and provided written informed consent before study participation in accordance with the ethical principles of the Declaration of Helsinki. This study was a single experiment without a control group. General characteristics of all participants in the group are shown in Table 1.

Belly-bike (Belly Bike Ltd., South Korea) was used for belly-dance intervention. This Belly-bike provides saddle swaying to subjects by pedaling power, with a swaying distance between left and right side of 0–15 cm (Fig. 1).

The Belly-bike group performed the intervention using the Belly-bike for 8 weeks, 30 minutes a day, 3 times a week. Some measurements were performed right before and after the total 8-week intervention. To measure the level of pain, visual analogue scale (VAS) and Korean Oswestry Disability Index (KODI) were used. In addition, flexibility tests such as straight leg raising test and forward reaching test in the long sitting posture were used to confirm back muscle shortness.

Activations of erector spinae, gluteus medius, rectus femoris, and vastus lateralis were also measured using EMG MP30 (BIOPAC System Inc., CA, USA) before and after the intervention. BSL3.7.3 (Biopbi System, USA) software was used for data storage by filtering with notch filtering at 60 Hz over the phase of 30–500 Hz for noise elimination. A distance of 2 cm was maintained between two electrodes to compare the potential difference. Muscle activation was expressed as %RVC (Reference Voluntary Contraction). Reference voluntary contraction showed moderate reliable method for patients who are unable to produce the maximal voluntary contraction and repeated tests.

Statistical Package for Social Sciences (SPSS) ver. 20.0 for Windows was used in this study to analyze the results. Shapiro-Wilk test was used to test data normality. For data with normality, a paired t-test was used to compare the differences

**Table 2.** The level of pain and flexibility in Belly-bike

| Variable | Pre-test | Post-test |
|---|---|---|
| VAS | 5.33 ± 2.13 | 0.73 ± 1.05[a] |
| KODI | 5.57 ± 4.33 | 1.00 ± 2.10[a] |
| FRT | 9.38 ± 10.45 | 13.15 ± 9.83[a] |
| SLRT | 69.43 ± 17.10 | 94.73 ± 15.42[a] |

*p<0.05, Mean ± SD, VAS: Visual Analogue Scale; KODI: Korean oswestry Disability Index; FRT: Forward reaching test; SLRT: Straight Leg Raising Test. [a]Significant difference between pre- and post-intervention values

**Table 3.** The changes of muscle activations in 4 muscles

| Variable | Pre-test | Post-test |
|---|---|---|
| ES (%RVC) | 5.08 ± 2.64 | 14.63 ± 27.71 |
| RF (%RVC) | 2.94 ± 3.00 | 10.95 ± 10.29[a] |
| GM (%RVC) | 8.59 ± 10.17 | 14.63 ± 13.93 |
| VL (%RVC) | 4.20 ± 3.19 | 12.61 ± 12.48[a] |

*p<0.05, Mean ± SD, ES: erector spine; RF: rectus femoris; GM: glutius medius; VL: vastus lateralis; RVC: reference voluntary contraction, [a]Significant difference between pre- and post-intervention values

between before and after intervention in the belly bike group.

All data were analyzed using SPSS ver. 18.0 for Windows, and α=0.05 was used as the level of significance.

## RESULTS

The VAS score was significantly decreased after the intervention in the Belly-bike group (p<0.05). In addition, the Belly-bike group showed a statistically significant decrease in the KODI score (p<0.05; Table 2). The result of forward reaching test was significantly different after the intervention in the Belly-bike group (p<0.05). A significant improvement in straight leg raising test was observed in the Belly-bike group (p<0.05; Table 2). Some increases in muscle activations were noted in the erector spinae and gluteus medius, but the difference was not statistically significant. Muscle activations of rectus femoris and vastus lateralis were significantly increased after the intervention in the Belly-bike group (p<0.05; Table 3).

## DISCUSSION

This study investigated the effects of exercise using an ergometer with a swaying saddle, which is called Belly-bike, on lower back pain. For assessment, we used the VAS score and KODI for the level of pain, straight leg raising and forward reaching tests for muscle flexibility, and EMG for muscle activation.

Regarding muscle flexibility, there were significant improvements in the Belly-bike group after the intervention, and these can be attributed to the belly dance function of the Belly-bike. A previous study reported that belly dance could improve the diverse functions of muscle. Srhoj reported that belly dance performance improved muscle flexibility and integrated coordination[17)]. The vibration and sway movement during belly dance changed muscle coordination, leading to correction of muscle imbalance. Our study finding is in line with that of Srhoj's study results. Furthermore, it is reported that aerobic exercises like belly dance and cycle exercises could improve muscle strength, endurance, and flexibility[14)]. Increased muscle strength and length would correct muscle imbalance, resulting in improved flexibility.

In EMG measurements, statistically significant changes were noted in two muscles—rectus femoris and vastus lateralis—but not in the erector spinae and gluteus medius. Previous studies reported that the weakness of pelvic flexors could cause weakness of the back muscles such as erector spinae, resulting in muscle imbalance around the pelvis[10)]. Janda reported that this imbalance could cause lower back pain; he added that once flexor muscles are improved, muscle imbalance would be corrected and lower back pain would be relieved. To increase muscle strength in flexors, strengthening exercise and aerobic exercise such as squad, sit-to-stand, walking, and cycle exercise are mainly recommended these days. Among them, cycle exercise is believed to have effects of strengthening and aerobic training at the same time. Many previous studies reported that cycle exercise provides repetitive and intermittent resistance, which is effective in increasing muscle strength. The results of this study are in line with those studies.

The scores of VAS and KODI were significantly decreased in the Belly-bike group after the intervention. It is reported in many previous studies that lower back pain occurs because of abnormal muscle balance around the pelvis and abdomen. Indeed, every subject in this study who suffered from lower back pain had imbalance between back muscles and lower extremity muscles. After the intervention with the Belly-bike, activation of the rectus femoris and flexibility of the hamstring muscles were increased. This possibly corrected the muscle imbalance around the pelvis, resulting in pain relief.

There are some limitations in this study. First, follow-up tests were not conducted, and second, all subjects were university students, not varying in age. For these reasons, the results of this study may not be generalized. Therefore, more studies with a design compensating for these limitations are needed in the future.

The results of this study showed that exercise using Belly-bike could be effective in reducing lower back pain. Many clinicians try to provide their patients with more affordable and easy ways to reduce pain. Based on this study's findings, it is believed that Belly-bike is a potential effective approach for the treatment of patients with lower back pain, as it increases muscle strength and flexibility and corrects muscle imbalance. Although the effect of findings is controversial among researchers, this study and further studies may deliver the evidence for this approach to be accepted in the clinical field and home environment.

## REFERENCES


1) Rozenberg S: [Chronic low back pain: definition and treatment]. Rev Prat, 2008, 58: 265–272. [Medline]
2) Croft PR, Papageorgiou AC, Ferry S, et al.: Psychologic distress and low back pain. Evidence from a prospective study in the general population. Spine, 1995, 20: 2731–2737. [Medline] [CrossRef]
3) Kovacs FM, Gestoso M, Gil del Real MT, et al.: Risk factors for non-specific low back pain in schoolchildren and their parents: a population based study. Pain, 2003, 103: 259–268. [Medline] [CrossRef]
4) Hartvigsen L, Kongsted A, Hestbaek L: Clinical examination findings as prognostic factors in low back pain: a systematic review of the literature. Chiropr Man Therap, 2015, 23: 13. [Medline] [CrossRef]
5) Page P, Frank CC, Lardner R: Assessment and treatment of muscle imbalance: the Janda approach. Champaign: Human Kinetics, 2010.
6) Nourbakhsh MR, Arab AM: Relationship between mechanical factors and incidence of low back pain. J Orthop Sports Phys Ther, 2002, 32: 447–460. [Medline] [CrossRef]
7) Kisner CL: Therapeutic exercise; foundations and techniques. Philadelphia: F.A. Davis, 2007.
8) Nadler SF, Wu KD, Galski T, et al.: Low back pain in college athletes. A prospective study correlating lower extremity overuse or acquired ligamentous laxity with low back pain. Spine, 1998, 23: 828–833. [Medline] [CrossRef]
9) Nadler SF, Malanga GA, DePrince M, et al.: The relationship between lower extremity injury, low back pain, and hip muscle strength in male and female collegiate athletes. Clin J Sport Med, 2000, 10: 89–97. [Medline] [CrossRef]
10) Nadler SF, Malanga GA, Bartoli LA, et al.: Hip muscle imbalance and low back pain in athletes: influence of core strengthening. Med Sci Sports Exerc, 2002, 34: 9–16. [Medline] [CrossRef]
11) Cooper RG, St Clair Forbes W, Jayson MI: Radiographic demonstration of paraspinal muscle wasting in patients with chronic low back pain. Br J Rheumatol, 1992, 31: 389–394. [Medline] [CrossRef]
12) Cailliet R: Low back pain syndrome. Philadelphia: F.A. Davis, 1988.
13) Purcell L, Micheli L: Low back pain in young athletes. Sports Health, 2009, 1: 212–222. [Medline] [CrossRef]
14) Coluccia P, Paffrath A, Putz J: Belly dancing—the sensual art of energy and spirit. Rochester: PPA Stree Press, 2005.
15) Ko SH: Effect of belly dance on the physical strength and bone density of elementary school pupils, Kunsan National University, Master's thesis, 2010.
16) Kim KD, Song YO, Baek YH: Effects of belly dancing and nutritional education on body composition and serum lipids profiles of obese women in a study, 'Obesity clinic projects at community health center'. Food Sci Nutr, 2011, 40: 1417–1422.
17) Srhoj L, Mihaljević D, Jukić J: Impact of motor abilities on belly dance performance in female high school students. Coll Antropol, 2008, 32: 835–841. [Medline]